------------------ 原始邮件 ------------------

主题: 专著

The relationship between the evolution of particle structure changes in the material structure of the universe, the initial state and final state of the physical universe and the changing steady state structure and the law of hyperrotation



①初态：宇宙大爆炸与基本粒子形成

宇宙的初态可以追溯到大约138亿年前的宇宙大爆炸。在这个时刻，宇宙非常热和密集，温度和密度都无法想象。随着宇宙的膨胀和冷却，基本粒子（如夸克和轻子）在大爆炸后的几十秒内形成，并开始结合形成更复杂的粒子，如质子和中子1。

恒态：宇宙结构的形成与演化

暗物质与可见物质的相互作用

在宇宙的演化过程中，暗物质和可见物质的相互作用对宇宙结构的形成和演化起到了关键作用。暗物质虽然无法直接观测到，但其引力作用对结构形成至关重要。暗物质的存在最早是由于观测到的星系旋转速度与预期不符而被提出的。暗物质通过重力作用促使普通物质向密度较高的区域聚集，从而引发了星系的形成和演化1。

星系与星系团的形成

星系是由数十亿到数千亿颗恒星以及气体和尘埃组成的巨大天体。在宇宙时间线的演变过程中，星系经历了形成、演化和合并的过程。星系的形成始于暗物质密度较高的区域吸引气体和尘埃聚集，最终导致恒星的诞生。在星系演化过程中，恒星的诞生、演化和死亡会不断改变星系的形态和性质。此外，星系之间的相互作用和合并也会影响其形状和大小。超星系团是由数百到数千个星系团组成的庞大结构，它们是宇宙中已知最大的结构之一，其尺度可达数百兆光年1。

末态：宇宙的未来与物质结构的变化

宇宙的无限大稳恒态模型

一些理论提出，宇宙可能是无限大且稳恒态的，而不是由大爆炸开始并最终走向热寂。在这种模型中，宇宙中不断地有恒星诞生与灭亡，宇宙以星云-恒星-黑洞-星云的过程永续发展，始终有冷态物质与热态物质。这种模型认为，宇宙中的可见物质和暗物质通过对称性全面破缺与恢复相互转化，暗物质的质量占比远远高于可见物质，不仅是引力场物质，也是所有场的载体2。

氢元素与星云的再生

在恒星的发展过程中，氢元素和氦元素不断演化成原子数更高的重元素。如果宇宙没有氢元素的不断再生，氢元素一定早已耗尽。因此，所有宇宙模型都必须解决氢元素再生的问题。此外，宇宙中所有的星系团都被暗物质的桥梁连接，星系团或近或远、联系或强或弱，没有任何一个星系或星系团能够孤立于宇宙之中。恒星不断释放大量物质和能量，影响着整个宇宙的结构和演化过程，因此所有宇宙模型还必须解决恒星与星系的再生问题2。

●②宇宙的物质结构和粒子结构在宇宙的初态、恒态和末态之间经历了复杂的变化和演化。从宇宙大爆炸的基本粒子形成，到暗物质和可见物质的相互作用导致的星系和星系团的形成，再到可能的无限大稳恒态宇宙模型中的物质再生和演化，这些过程展示了宇宙的动态性和

复杂性。理解这些变化和演化对于揭示宇宙的起源、发展和未来至关重要。

宇宙初态的理论模型

宇宙初态的理论模型主要指的是大爆炸理论（Big Bang Theory）。大爆炸理论认为，宇宙起源于约138亿年前的一个极高温度和极高密度的状态，然后开始膨胀和冷却。这个理论得到了广泛的证据支持，包括宇宙微波背景辐射的发现、星系的红移以及宇宙元素丰度的观测。

大爆炸理论的发展

爱因斯坦的广义相对论：爱因斯坦在1915年提出的广义相对论为大爆炸理论奠定了基础。1922年，亚历山大·弗里德曼从不含宇宙项的场方程中得到三维各向同性的宇宙解，描述了一个膨胀的宇宙1。

哈勃定律：1929年，埃德温·哈勃观察到星系光谱的红移和距离之间的线性关系，即哈勃定律，这进一步支持了宇宙膨胀的观点1。

哈勃定律概述

哈勃定律是由美国天文学家埃德温·哈勃于1929年提出的，指出宇宙

中遥远星系的退行速度与它们距离地球的距离成正比。具体来说，距离越远的星系，其后退速度越快。这一发现为现代宇宙学奠定了基础，成为我们理解宇宙演化的重要工具。哈勃定律的数学公式可以表示为：

$$v = H_0 r$$

其中，(v) 表示星系的视向速度，(r) 表示星系的距离，(H_0) 是哈勃常数[3]。

小尺度上的适用性

在较小的尺度上，例如在银河系内部，哈勃定律并不适用。这是因为银河系内的恒星和其他天体的运动受到多种因素的影响，包括引力相互作用、旋转动力学等。在这种情况下，恒星光谱既有红移，也有蓝移，表明有些恒星在靠近地球，有些在远离地球。此外，银河系内天体的运动速度通常较低，通常仅为每秒几公里或数十公里，这与哈勃定律所描述的大尺度宇宙膨胀现象不符[1]。

中尺度上的适用性

在中等尺度上，例如在本星系群（Local Group）内，哈勃定律的适用性仍然有限。本星系群包括银河系、仙女座星系等数十个星系，这些星系之间的相对运动受到彼此引力的影响。因此，在这个尺度上，

星系的运动更复杂，不能简单地用哈勃定律来描述。然而，随着尺度的增大，星系群之间的平均退行速度会逐渐符合哈勃定律的预测1。

大尺度上的适用性

在大尺度上，例如在超星系团（Superclusters）和更大的宇宙结构中，哈勃定律得到了较好的验证。在这个尺度上，宇宙的膨胀效应占主导地位，星系之间的相对运动主要由宇宙膨胀驱动，而不是局部的引力相互作用。因此，距离越远的星系，其退行速度越快，这与哈勃定律的预言一致。大量的观测数据支持了哈勃定律在大尺度上的适用性1。

哈勃定律描述了遥远星系的退行速度与其距离成正比的关系，这一定律在宇宙边缘的具体表现主要体现在以下几个方面：

1. 退行速度显著增加

根据哈勃定律，随着星系距离的增加，其退行速度也会相应增加。在宇宙边缘，由于星系距离地球极其遥远，因此它们的退行速度会变得非常大。这种现象可以通过哈勃定律的数学表达式（$v = H_0 r$）来解释，其中（v）表示星系的视向速度，（r）是星系的距离，（H_0）是哈勃常数。当（r）非常大时，（v）也会相应地变得非常大1。

2. 红移现象更加明显

哈勃定律的观测基础之一是多普勒效应，即由于星系的远离运动导致其光谱线发生红移。在宇宙边缘，由于星系的退行速度极大，因此其光谱线的红移现象会更加显著。这种红移可以通过光谱分析技术观测到，从而验证哈勃定律的有效性1。

3. 宇宙膨胀的直接证据

哈勃定律提供的证据支持了宇宙膨胀的理论。在宇宙边缘，星系的高速退行进一步证明了宇宙在不断扩张的事实。这一发现对于理解宇宙的起源和演化具有重要意义，因为宇宙膨胀是大爆炸理论的重要组成部分2。

4. 哈勃常数的挑战

在宇宙边缘，由于距离极远，测量星系的退行速度和距离变得更加困难，这给哈勃常数的精确测定带来了挑战。不同的观测技术和数据来源可能会导致不同的哈勃常数值，进而影响对宇宙年龄和其他关键参数的计算2。

哈勃定律在宇宙边缘的表现主要体现在退行速度显著增加、红移现象更加明显、提供宇宙膨胀的直接证据以及对哈勃常数测定的挑战等方面。这些表现不仅验证了哈勃定律的有效性，也为深入理解宇宙的起源和演化提供了重要的观测依据。

哈勃定律在不同尺度上的适用性有所不同。在小尺度和中尺度上，由于局部引力相互作用的影响，哈勃定律的适用性有限。而在大尺度上，宇宙膨胀效应占主导地位，哈勃定律得到了较好的验证。因此，哈勃定律主要适用于描述大尺度宇宙的膨胀现象，而不适用于描述小尺度和中尺度的局部天体运动。

●③宇宙微波背景辐射：20世纪60年代，阿诺·彭齐亚斯和罗伯特·威尔逊发现了宇宙微波背景辐射，这是大爆炸理论的另一个重要证据。

宇宙末态的理论模型

宇宙末态的理论模型则涉及宇宙未来的命运，主要有几种可能的情景：

热寂（Heat Death）

热寂是宇宙末态的一种理论模型，认为随着宇宙的膨胀，星系之间的距离会越来越大，最终所有的恒星都会耗尽其核燃料，宇宙将进入一个高熵状态，没有任何可用的能量可以做功。这种情景基于热力学第二定律，即熵总是增加的。

大撕裂（Big Rip）

大撕裂是另一种可能的宇宙末态，假设暗能量的密度会随着时间的推移而增加，导致宇宙膨胀加速到一个临界点，最终所有的物质，甚至原子和亚原子粒子，都会被撕裂。

大坍缩（Big Crunch）

大坍缩是与大爆炸相反的情景，假设宇宙的膨胀最终会停止并逆转，导致宇宙再次收缩回一个极高温度和极高密度的状态。然而，目前的观测数据显示宇宙的膨胀速度正在加快，而不是减慢，因此大坍缩的可能性较低。

ΛCDM模型

目前最广泛接受和使用的宇宙学模型是ΛCDM模型，也称为冷暗物质模型（Lambda Cold Dark Matter Model）。这个模型基于爱因斯坦的广义相对论，假设宇宙是均匀且各向同性的，并且由普通物质、暗物质和暗能量组成3。

ΛCDM模型的主要成分

普通物质：我们能够直接或间接观测到的物质，如星星、行星、气体、尘埃等，约占宇宙物质总量的15%。

暗物质：一种我们还不知道具体性质的物质，但可以通过其引力效应推断其存在，约占宇宙物质总量的85%。

暗能量：一种神秘的能量形式，具有负的压强，并且随着宇宙的膨胀而增加，推动宇宙加速膨胀。


④宇宙初态的理论模型主要是大爆炸理论，而宇宙末态的理论模型则有多种可能性，包括热寂、大撕裂和大坍缩。目前最广泛接受的宇宙学模型是ΛCDM模型，它为我们提供了一个框架来描述和理解宇宙的起源、结构和演化。

大爆炸理论是目前科学界最广泛接受的宇宙起源理论，它描述了宇宙从一个极其高温高密度的状态急剧扩展到今天广袤宇宙的过程。然而，关于大爆炸发生前的具体状态，科学界并没有达成一致的结论，以下是几种主要的猜想和理论：

虚无状态

一种常见的观点是，大爆炸发生前宇宙的状态是虚无，即宇宙中没有任何物质存在。这种观点认为，大爆炸标志着时间和空间的起点，宇宙中的所有物质和能量都是从这次大爆炸中产生的3。

奇点状态

另一种观点认为，大爆炸发生前宇宙处于一个奇点状态，这是一个具有无穷大能量密度和温度的点。在这个状态下，现有的物理定律失效，无法描述其真实情况。奇点状态是大爆炸理论的一个极限情况，但科学家们无法解释为什么和如何会发生从奇点到大爆炸的转变2。

循环模型

一些科学家提出了循环模型，认为宇宙经历了多次大爆炸和大坍缩的周期性循环。在这种模型中，大爆炸并不是宇宙的起点，而是一个更大周期中的一个阶段。大爆炸发生前，宇宙可能已经经历了无数次类似的膨胀和收缩过程2。

量子涨落

还有理论提出，大爆炸可能是由量子涨落引起的。在这种观点中，宇宙从一个高度不确定的量子态中诞生，大爆炸是量子涨落导致的一种极端情况。这种理论试图将量子力学与广义相对论结合起来，以解释大爆炸的发生3。

大爆炸理论所描述的大爆炸发生前的宇宙状态仍然是一个未解之谜。科学界提出了多种猜想和理论，包括虚无状态、奇点状态、循环模型和量子涨落等，但目前还没有确凿的证据来支持其中的任何一种理

论。随着科学技术的进步，未来可能会有更多的发现来揭示这一宇宙起源之谜。.

宇宙膨胀理论是现代宇宙学中的一个重要领域，近年来，科学家们在这个领域取得了一些新的研究成果。以下是根据最新的搜索结果总结的一些重要发现。

宇宙膨胀的不均匀性

近期的研究发现，宇宙的膨胀并不是均匀的，而是呈现出更加多样化或“更加不均匀”的方式在膨胀。传统的宇宙学模型假设宇宙的膨胀是均匀的，但新的研究表明，这种假设可能并不完全正确。研究人员通过对Ia型超新星的增强光变曲线分析，发现宇宙的膨胀速度在不同的区域有所不同。在引力较强的星系区域，时间流逝得更慢，而在宇宙空洞，即广阔的空旷区域，时间流逝得更快。这种差异导致了所谓的“皱褶”时空结构，光线穿过这些区域时会被拉伸，模拟出加速膨胀的效果。因此，宇宙可能并没有真实地在物理层面加速膨胀，而是由于人们对非均匀宇宙的时间和距离校准方式导致的观测效应1。

● ⑤暗能量的存在与否

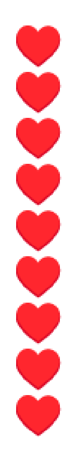
暗能量被认为是推动宇宙加速膨胀的神秘力量，但最新的研究对此提出了质疑。传统的宇宙学模型假设暗能量是一种未知的、占主导地位的能量形式，它对宇宙产生负压作用，抵消引力，从而推动宇宙加速膨胀。然而，新的研究发现，通过分析Ia型超新星光变曲线，宇宙的

膨胀可能是由于非均匀宇宙的时间和距离校准方式导致的观测效应，而不是真正的加速膨胀。这表明，暗能量可能并不存在，或者它的作用方式与传统假设的不同1。

宇宙膨胀理论的发展

宇宙膨胀理论的发展经历了漫长的历史过程。从最初的稳恒态宇宙观，到爱因斯坦引入宇宙常数以保持宇宙静止，再到哈勃发现宇宙膨胀，以及后来的大爆炸宇宙理论的提出和发展，宇宙膨胀理论一直是宇宙学研究的核心。近年来，随着观测技术的进步，科学家们对宇宙膨胀的理解也在不断深化。例如，宇宙微波背景辐射的发现为大爆炸理论提供了强有力的支持，而暗能量的发现则为宇宙膨胀理论带来了新的挑战和机遇23。

宇宙膨胀理论的最新研究成果揭示了宇宙膨胀的复杂性和多样性，挑战了传统的宇宙学模型，并为未来的宇宙学研究指明了方向。





⑥星体旋转的原因及其重要性

宇宙中的天体旋转是一个普遍现象，这一现象不仅存在于宏观的天体如恒星和星系，也贯穿于微观粒子层面。天体的旋转与其形成过程密切相关。根据万有引力定律，宇宙中的天体之间存在引力作用，这种作用力会导致天体之间的相互吸引，从而避免碰撞。因此，天体的旋转不仅是避免碰撞的一种方式，也是宇宙演化过程中的一个重要组成部分1。

天体旋转的形成机制

天体的旋转与其形成过程密切相关。宇宙大爆炸初期产生的星云在外部干扰下，如附近的超新星爆发，将会坍缩形成恒星、行星、卫星以及其他各种小天体。星云的组成粒子会互相碰撞，使得星云的净角动量不为零，从而导致星云在某个方向上有一个整体运动，并随着引力坍缩，星云会在该方向上越转越快。最终，恒星从星云中心形成，并因角动量守恒而保持自转1。

旋转对天体稳定性的影响

旋转不仅是天体避免碰撞的一种方式，也是天体保持稳定性的关键因素。没有转动的天体已经在引力的作用下发生碰撞并消失，留下来的都是会转动的天体。这种旋转使得天体能够在引力的作用下保持一定的稳定性，从而形成我们今天所观测到的宇宙结构1。

宇宙结构与粒子结构的关联

宇宙结构的旋转特性

在宏观尺度上，星系的旋转模式可以帮助科学家了解其质量分布和演化过程。例如，太阳系的行星绕太阳旋转，这不仅决定了行星的运动轨迹，还影响了它们的气候和季节变化。在更大的尺度上，星系的旋转模式揭示了宇宙的结构和发展2。

微观粒子旋转与宏观天体旋转的联系

在微观世界里，粒子的自旋同样遵循着类似的原理。虽然自旋与经典物理学中的旋转有所区别，但它们背后的基本原理——角动量的守恒——是一致的。这进一步证实了旋转在宇宙中无所不在的特性，无论是在宏观的天体还是微观的粒子层面2。

宇宙旋转对结构演化的影响

旋转对于宇宙的结构和发展有着深远的影响。例如，星系的旋转模式可以帮助科学家了解其质量分布和演化过程。此外，宇宙的早期状态和温度对旋转现象的普遍性也至关重要。当物质冷却下来后，它可以更容易地形成稳定的结构，如恒星、行星甚至整个星系。在这些结构的形成过程中，原始的角动量被保留了下来，因此新生成的天体自然

会保持旋转的状态2。

宇宙大尺度旋转的可能性探讨

宇宙大尺度旋转的理论基础

广义相对论为我们理解宇宙的大尺度结构提供了理论基础。在这个理论框架下，宇宙的大尺度结构，如星系、星系团和更大的结构，如超星系团，都是在宇宙的扩张过程中形成的。随着宇宙的扩张，这些结构在广义相对论的作用下进行了复杂的动态进化3。

宇宙大尺度旋转的观测证据

尽管宇宙在大尺度上旋转的理论尚未得到确凿的观测证据，但一些研究暗示，在宇宙微波背景辐射（CMB）的某些区域确实存在某种形式的偏斜，这可能与宇宙的大尺度旋转有关。然而，这些观察结果还不足以确定宇宙是否真的在旋转，因为还有其他因素，如宇宙的各种波动和不均匀性，也可能造成类似的效果3。

宇宙旋转的未来研究方向

星球天体超旋化旋动定律概述

星球天体的超旋化旋动定律主要研究行星内部的磁场生成机制及其演化过程。通过对冷巨行星的磁场进行数值模拟，科学家们能够深入了解行星磁场的拓扑结构和强度随时间的演变1。这些研究对于理解行星的演化、宜居性和大气动力学具有重要意义。

●⑦行星磁场的生成机制

行星磁场的生成通常涉及到行星内部的金属元素（如铁）通过核聚变反应产生电子，这些电子在行星内部的磁场中流动，从而形成磁场。此外，行星内部的液态金属核心的运动也会产生磁场。

行星磁场的演化过程

行星磁场的演化过程受到多种因素的影响，包括行星内部的热力学状态、金属元素的分布以及行星自转速度等。通过对不同行星的磁场进行数值模拟，科学家们发现行星磁场在不同演化阶段表现出不同的拓扑结构和强度1。

宇宙结构与粒子结构的关联

宇宙结构和粒子结构之间存在着密切的联系，这种联系主要体现在宇宙的基本组成单元——基本粒子和基本力之间的相互作用上。

宇宙的基本组成单元

宇宙的基本组成单元包括基本粒子和基本力。基本粒子包括夸克、轻子等，而基本力则包括电磁力、核力等。这些基本粒子和基本力共同构成了宇宙的基本框架。

基本粒子和基本力的相互作用

基本粒子和基本力之间的相互作用是宇宙演化的动力源泉。例如，电磁力使得原子能够形成分子，从而构成了各种复杂的物质结构；核力则使得原子核能够稳定存在，从而维持了原子的结构。

星球天体超旋化旋动定律与宇宙结构和粒子结构的关联

星球天体的超旋化旋动定律与宇宙结构和粒子结构之间存在着密切的联系。这种联系主要体现在以下几个方面：

行星磁场的生成机制与宇宙基本力的相互作用

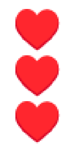
行星磁场的生成机制涉及到金属元素通过核聚变反应产生电子，这些电子在行星内部的磁场中流动，从而形成磁场。这一过程类似于基本粒子之间的相互作用，如夸克通过强相互作用形成质子和中子。

行星磁场的演化过程与宇宙结构的演变

行星磁场的演化过程受到多种因素的影响，包括行星内部的热力学状态、金属元素的分布以及行星自转速度等。这些因素的变化类似于宇宙结构在不同时间尺度上的演变，如星系、星系团的形成和演化。

星球天体超旋化旋动定律对宇宙结构和粒子结构研究的启示

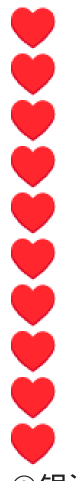
通过对星球天体的超旋化旋动定律的研究，科学家们可以深入了解行星磁场的生成机制和演化过程，从而为研究宇宙结构和粒子结构提供新的视角和方法。例如，通过研究行星磁场的拓扑结构和强度随时间的演变，科学家们可以探索宇宙中物质和能量的分布和演化规律。


⑧总之，星球天体的超旋化旋动定律与宇宙结构和粒子结构之间存在着密切的联系。通过对星球天体的超旋化旋动定律的研究，科学家们可以为研究宇宙结构和粒子结构提供新的视角和方法，从而推动宇宙学的发展。

尽管目前还没有确凿的证据支持宇宙在大尺度上的旋转，但未来的研究可能会为我们提供更多关于这一问题的线索。例如，更精确的观测设备和进一步的研究可能会揭示更多关于宇宙旋转的证据。此外，对

宇宙早期状态的研究也可能为我们理解宇宙是否存在旋转提供新的视角3。

星球天体的超旋化旋动定律与宇宙结构及粒子结构的关联密不可分。从宏观的天体到微观的粒子，旋转不仅是一种普遍现象，而且对宇宙的结构和发展有着深远的影响。未来的研究可能会为我们提供更多关于这一问题的线索，帮助我们更好地理解宇宙的本质和演变。



⑨银河系暗物质晕形状研究

银河系作为一个典型的盘状星系，表现出翘曲特征。天文学家通过研究银盘的翘曲进动，可以揭示银河系的结构和演化。

利用盖亚卫星发现的2600颗年轻经典造父变星作为银河系翘曲的示踪天体，并结合郭守敬望远镜巡天数据精确测量这些造父变星的距离和年龄。首创"时光动画"方法，精确描绘出距今2.5亿年间不同年龄切片

的银盘三维结构1。

通过动画"放映"方式，研究清晰揭示出银盘翘曲的演化过程，发现翘曲沿着逆太阳旋转方向以每百万年0.12度的速率进动。这一发现对于理解银河系的结构和动力学具有重要意义1。

Ia型超新星研究

Ia型超新星因其爆发相关参数可作为测量遥远距离并计算宇宙膨胀率（哈勃常数）的"标准烛光"。然而，使用不同方法测量哈勃常数得到的值存在差异，引发了对宇宙学标准模型的怀疑。

研究团队利用JWST高级深星系外巡天的数据，发现了最古老的Ia型超新星，以及其他80颗超新星。计划对这些超新星开展更深入研究，以确定其金属含量和确切距离2。

这一发现本质上打开了一扇关于瞬态宇宙的新窗口，有助于消除哈勃常数测量中的差异，进一步验证宇宙学标准模型2。

偶极超固体涡旋研究

超固体这一理论概念提出这种物质状态同时具备固体和超流体的特性。偶极相互作用在超固体的研究中起到了至关重要的作用。

EvaCasotti等人在《Nature》杂志上发表的研究中，利用具有强磁偶极矩的铒原子，实现了偶极玻色-爱因斯坦凝聚(BEC)并向超固体相转变。通过在光学晶格中困住超冷铒原子，进行了实验3。

在偶极超固体中观察到的涡旋展示了丰富而复杂的动力学特性，弥合了经典涡旋在固态系统和量子涡旋在超流体中的研究之间的差距，具有重要的理论意义3。

量子龙卷风制造地球黑洞研究

旋转的黑洞（克尔黑洞）具有角动量，会在其旋转的方向上拖动周围的时空结构，这种现象被称为"框架拖曳"。

通过将数以万计的量子限制在一个类似于小型龙卷风的紧凑物体中，实现了量子流体领域中强度破纪录的涡流。更复杂的实验将这项研究提升到了一个新的水平4。

这一研究可能最终导致预测量子场在天体物理黑洞周围弯曲时空中的行为，为理解黑洞的性质提供了新的视角4。

- ⑩超导量子计算进展

超导量子比特具有规模化拓展的优势，近年来发展迅速。实现大规模的多量子比特纠缠一直是各国科学家奋力追求的目标。

该工作将各个量子系统中真纠缠比特数目的纪录由原先的24个大幅突破至51个，充分展示了超导量子计算体系优异的可扩展性，对于多体量子纠缠研究、大规模量子算法实现以及基于测量的量子计算具有重要意义5。

超大质量黑洞自旋研究

超大质量黑洞及其吸积盘和相对论性喷流之间的能量转移机制一直困扰着物理学家和天文学家。一个流行的理论认为，可以从旋转的黑洞中提取能量，允许超大质量黑洞周围的一些物质以巨大的能量喷射出来。

通过分析过去23年获得的M87的VLBI数据，研究小组在其底部检测到周期性的岁差喷射流，从而深入了解中心黑洞的状态6。

探测到这种进动提供了明确的证据，证明M87中的超大质量黑洞确实在旋转，从而增强了我们对超大质量黑洞本质的理解6。

这些最新的研究进展不仅在理论上推动了我们对星球天体超旋化旋动定律的理解，而且在实际应用中也展现了巨大的潜力。从银河系暗物质晕的形状研究到超导量子计算的进展，每一项成果都为未来的科学

研究开辟了新的道路。

宇宙膨胀与暗能量

近期，新西兰坎特伯雷大学的一组物理学家和天文学家对宇宙膨胀的传统观点提出了挑战。他们通过对Ia型超新星进行增强光变曲线分析，发现宇宙的膨胀方式比之前认为的更加多样化或“不均匀”，并且暗能量可能实际上并不存在1。这一发现支持了“时间景观”模型，该模型试图解释宇宙加速膨胀的现象而无需假设暗能量的存在。研究指出，在引力较强的星系区域，时间流逝得更慢，而在宇宙空洞（广阔的空旷区域），时间流逝得更快，这种差异创造了所谓的“皱褶”时空结构。

I宇宙年龄的新认识

初态：宇宙的起源

大爆炸宇宙模型

在宇宙学的研究中，最广泛接受的宇宙起源模型是大爆炸模型。该模型认为宇宙起源于约138亿年前的一个极高温度和密度的状态，随后经历了快速的膨胀和冷却，形成了今天我们所观察到的宇宙结构1。

稳恒态宇宙模型

另一种早期的宇宙模型是稳恒态宇宙模型，由邦迪、戈尔德和福雷德·霍伊尔在1948年提出。该模型认为宇宙在时间和空间上都是无限的，宇宙的膨胀伴随着新物质的不断产生，以保持宇宙物质的密度不变。这一模型试图解决大爆炸模型中关于宇宙年龄的问题，但最终由于与观测结果不符而未能获得广泛认可1。

末态：宇宙的命运

大爆炸模型的末态

在大爆炸模型中，宇宙的末态取决于宇宙的总密度。如果宇宙的密度足够高，引力将最终导致宇宙的收缩，可能经历一次“大坍缩”。如果密度较低，宇宙将继续膨胀，直到所有恒星耗尽燃料，进入一个寒冷、黑暗的“热寂”状态1。

稳恒态宇宙模型的末态

稳恒态宇宙模型则假设宇宙没有真正的末态，因为它认为宇宙在时间和空间上都是无限的，且物质不断产生以维持恒定的密度。因此，该模型没有明确的末态概念1。

变化运动的恒态

宇宙的动态演化

无论是大爆炸模型还是稳恒态模型，宇宙都在不断地运动和变化。在大爆炸模型中，宇宙从一个高密度、高温的状态开始，逐渐膨胀和冷却，形成了星系、恒星和行星。在稳恒态模型中，虽然宇宙整体上保持不变，但局部区域的物质分布会发生变化，新的星系不断形成，旧的星系逐渐老化1。


II微观粒子的动态演化

在微观层面，粒子也在不断地运动和变化。例如，电子绕原子核旋转，原子会振动、衰变并向外辐射能量。光子、中微子和其他基本粒子在空间中高速移动，物质之间不断进行能量的交换和转移。这些微观粒子的变化过程也是时间流逝的表现2。

宇宙和粒子结构的初态、末态及变化运动的恒态构成了我们对宇宙演化的理解。大爆炸模型提供了目前最被广泛接受的宇宙起源和末态的描述，而稳恒态模型则提出了一个不同的视角，尽管它在现代观测证据面前显得不足。无论哪种模型，宇宙和粒子的动态演化都是其核心特征，体现了宇宙的永恒变化和运动。

新类型的宇宙X射线源

华沙大学天文台带领的国际天文学家团队发现了一类全新的宇宙X射线源，称为Millinovae，其亮度是太阳的100倍以上3。这些天体在持续数月的爆发期间，亮度会显著增加，有些天体每隔几年爆发一次，而有些只爆发过一次。这一发现为理解神秘的天体现象提供了新的线索，并揭示了宇宙中一些极端条件下的物理过程。

年轻星团中的双星系统

多伦多大学的研究人员在年轻星团中首次发现了成对的白矮星和主序星4。这一发现有助于弥合双星系统最早和最后阶段之间的差距，对于理解恒星形成、星系演化以及宇宙中元素的产生具有重要意义。此外，这些双星系统可能是解释超新星爆发和引力波等现象的关键。

综上所述，这些最新研究发现为我们提供了对宇宙膨胀、年龄、X射线源以及恒星演化等方面的新见解，进一步深化了我们对宇宙的理解。

① Initial state: BIGBANG and the formation of elementary particles.

The initial state of the universe can be traced back to BIGBANG about 13.8 billion years ago. At this moment, the universe is very hot

and dense, and the temperature and density are unimaginable. With the expansion and cooling of the universe, elementary particles (such as quarks and leptons) formed within tens of seconds after the Big Bang and began to combine to form more complex particles, such as protons and neutrons 1.

Steady state: the formation and evolution of cosmic structure

Interaction between dark matter and visible matter

In the evolution of the universe, the interaction between dark matter and visible matter plays a key role in the formation and evolution of the structure of the universe. Although dark matter can't be directly observed, its gravitational effect is very important to the structure formation. The existence of dark matter was first proposed because the observed rotation speed of galaxies was inconsistent with expectations. Dark matter urges ordinary matter to gather in high-density areas through gravity, which leads to the formation and evolution of galaxies.

Formation of galaxies and clusters of galaxies

Galaxies are huge celestial bodies composed of billions to hundreds of billions of stars, gas and dust. In the evolution of the cosmic timeline, galaxies have experienced the process of formation,

evolution and merger. The formation of galaxies begins with the region with high density of dark matter attracting gas and dust, which eventually leads to the birth of stars. In the process of galaxy evolution, the birth, evolution and death of stars will constantly change the shape and properties of galaxies. In addition, the interaction and merger between galaxies will also affect their shape and size. Supercluster is a huge structure composed of hundreds to thousands of clusters, which is one of the largest known structures in the universe, and its scale can reach hundreds of trillion light-years 1.

Final state: the future of the universe and the change of material structure

Infinite steady-state model of the universe

Some theories suggest that the universe may be infinite and steady, instead of starting with the big bang and eventually going to thermal death. In this model, stars are constantly born and dying in the universe, and the universe develops in a process of nebula-star-black hole-nebula, and there are always cold matter and hot matter. According to this model, the visible matter and dark matter in the universe are transformed into each other through comprehensive symmetry breaking and recovery, and the mass proportion of dark matter is much higher than that of visible matter, which is not only the gravitational field material, but also the carrier of all fields.

Hydrogen and Nebula Regeneration

During the development of stars, hydrogen and helium elements constantly evolve into heavy elements with higher atomic number. If there were no constant regeneration of hydrogen in the universe, hydrogen would have been exhausted long ago. Therefore, all universe models must solve the problem of hydrogen regeneration. In addition, all the galaxy clusters in the universe are connected by dark matter bridges, and the galaxy clusters are near or far, and the connection is strong or weak. No galaxy or galaxy cluster can be isolated from the universe. Stars constantly release a lot of matter and energy, which affects the structure and evolution of the whole universe, so all universe models must also solve the problem of the regeneration of stars and galaxies.

● ② The material structure and particle structure of the universe have undergone complex changes and evolution between the initial state, the constant state and the final state of the universe. From the formation of elementary particles in BIGBANG, to the formation of galaxies and galaxy clusters caused by the interaction between dark matter and visible matter, and then to the regeneration and evolution of matter in the possible infinite steady-state universe model, these processes show the dynamics and complexity of the universe. Understanding these changes and evolution is very important to reveal the origin, development and future of the universe.

Theoretical model of the initial state of the universe

The theoretical model of the initial state of the universe mainly refers to the Big Bang Theory. According to the Big Bang theory, the universe originated from a state of extremely high temperature and density about 13.8 billion years ago, and then began to expand and cool. This theory is supported by a wide range of evidence, including the discovery of cosmic microwave background radiation, the red shift of galaxies and the observation of cosmic element abundance.

Development of the Big Bang Theory

Einstein's general theory of relativity: Einstein's general theory of relativity put forward in 1915 laid the foundation for the big bang theory. In 1922, Alexander Friedman got a three-dimensional isotropic cosmological solution from a field equation without cosmological terms, and described an expanding cosmos 1.

Hubble's Law: In 1929, Edwin Hubble observed the linear relationship between the red shift of the galaxy spectrum and the distance, that is, Hubble's Law, which further supported the viewpoint of the expansion of the universe.

Overview of Hubble's law

Hubble's law was put forward by American astronomer Edwin Hubble in 1929, pointing out that the retrogression speed of distant

galaxies in the universe is directly proportional to their distance from the earth. Specifically, the farther away a galaxy is, the faster it retreats. This discovery laid the foundation for modern cosmology and became an important tool for us to understand the evolution of the universe. The mathematical formula of Hubble's law can be expressed as:

$$v = H_0 r$$

Where (v) represents the apparent velocity of galaxies, (r) represents the distance of galaxies, and (H_0) is Hubble constant 3.

Applicability on a small scale

On smaller scales, such as inside the Milky Way, Hubble's law does not apply. This is because the motions of stars and other celestial bodies in the Milky Way are influenced by many factors, including gravitational interaction and rotational dynamics. In this case, the spectra of stars are both red-shifted and blue-shifted, indicating that some stars are close to the earth and some are far away from it. In addition, the speed of celestial bodies in the Milky Way is usually low, usually only a few kilometers or dozens of kilometers per second, which is inconsistent with the large-scale expansion of the universe described by Hubble's law.

Mesoscale applicability

On the medium scale, such as in the Local Group, the applicability of Hubble's law is still limited. The local galaxy group includes dozens of galaxies such as the Milky Way and Andromeda, and the relative motion between these galaxies is influenced by each other's gravity. Therefore, at this scale, the motion of galaxies is more complicated and cannot be simply described by Hubble's law. However, with the increase of scale, the average regression speed between galaxy groups will gradually conform to the prediction of Hubble's law 1.

Applicability on a large scale

On a large scale, such as in Superclusters and larger cosmic structures, Hubble's law has been well verified. At this scale, the expansion effect of the universe is dominant, and the relative motion between galaxies is mainly driven by the expansion of the universe, rather than the local gravitational interaction. Therefore, the farther away the galaxy is, the faster its retrogression will be, which is consistent with the prediction of Hubble's law. A large number of observation data support the applicability of Hubble's law on a large scale.

Hubble's law describes the relationship between the retrogression speed of distant galaxies and their distance. The specific performance of this law at the edge of the universe is mainly

reflected in the following aspects:

1. The retrogression speed is significantly increased.

According to Hubble's law, with the increase of galaxy distance, its retrogression speed will also increase accordingly. At the edge of the universe, because galaxies are extremely far away from the earth, their retrogression speed will become very large. This phenomenon can be explained by the mathematical expression of Hubble's law ($v = H_0 r$), where (v) represents the apparent velocity of galaxies, (r) is the distance of galaxies, and (H_0) is the Hubble constant. When (r) is very large, (v) will correspondingly become very large by 1.

2. The phenomenon of redshift is more obvious.

One of the observation bases of Hubble's law is Doppler effect, that is, the spectral lines of galaxies are red-shifted due to their distant motion. At the edge of the universe, because of the great retrogression speed of galaxies, the red shift of their spectral lines will be more obvious. This red shift can be observed by spectral analysis technology, thus verifying the validity of Hubble's law.

3. Direct evidence of the expansion of the universe

The evidence provided by Hubble's law supports the theory of cosmic expansion. At the edge of the universe, the rapid regression of galaxies further proves the fact that the universe is expanding. This discovery is of great significance for understanding the origin and evolution of the universe, because the expansion of the universe is an important part of the Big Bang theory.

4. The challenge of Hubble constant

At the edge of the universe, it is more difficult to measure the retrogression speed and distance of galaxies because of the extreme distance, which brings challenges to the accurate determination of Hubble constant. Different observation techniques and data sources may lead to different Hubble constant values, which will affect the calculation of the age of the universe and other key parameters.

The performance of Hubble's law at the edge of the universe is mainly reflected in the obvious increase of regression speed, the more obvious redshift phenomenon, the direct evidence of the expansion of the universe and the challenge to the determination of Hubble's constant. These performances not only verify the validity of Hubble's law, but also provide an important observation basis for deeply understanding the origin and evolution of the universe.

Hubble's law has different applicability at different scales. On small and medium scale, due to the influence of local gravitational

interaction, the applicability of Hubble's law is limited. On the large scale, the expansion effect of the universe is dominant, and Hubble's law has been well verified. Therefore, Hubble's law is mainly suitable for describing the expansion phenomenon of the large-scale universe, but not for describing the local celestial motion at small and medium scales.

● ③ Cosmic microwave background radiation: In 1960s, arno penzias and robert wilson discovered cosmic microwave background radiation, which is another important evidence of the Big Bang theory.

Theoretical model of the final state of the universe

The theoretical model of the final state of the universe involves the future fate of the universe, and there are mainly several possible scenarios:

Heat Death (heat death)

Thermal silence is a theoretical model of the last state of the universe. It is believed that with the expansion of the universe, the distance between galaxies will become larger and larger, and eventually all the stars will run out of their nuclear fuel, and the universe will enter a state of high entropy, and there is no available

energy to do work. This scenario is based on the second law of thermodynamics, that is, entropy always increases.

Big Rip (big rip)

The big tear is another possible final state of the universe. It is assumed that the density of dark energy will increase with the passage of time, leading to the acceleration of the expansion of the universe to a critical point, and eventually all substances, even atoms and subatomic particles, will be torn.

Big Crunch

The Big Collapse is the opposite of the Big Bang, assuming that the expansion of the universe will eventually stop and reverse, causing the universe to shrink back to a state of extremely high temperature and density. However, the current observation data show that the expansion of the universe is accelerating, not slowing down, so the possibility of a big collapse is low.

λ ΛCDM model

At present, the most widely accepted and used cosmological model is λ ΛCDM model, also known as Lambda Cold Dark Matter Model.

Based on Einstein's general theory of relativity, this model assumes that the universe is homogeneous and isotropic, and consists of ordinary matter, dark matter and dark energy.

Main components of λ ΛCDM model

Ordinary matter: Things that we can directly or indirectly observe, such as stars, planets, gases, dust, etc., account for about 15% of the total matter in the universe.

Dark matter: a substance whose specific properties are unknown, but its existence can be inferred by its gravitational effect, accounting for about 85% of the total matter in the universe.

Dark energy: a mysterious form of energy with negative pressure, which increases with the expansion of the universe and promotes the accelerated expansion of the universe.

④ The theoretical model of the initial state of the universe is mainly the Big Bang theory, while the theoretical model of the final state of the universe has many possibilities, including thermal death, big tear and big collapse. At present, the most widely accepted cosmological model is λ ΛCDM model, which provides us with a framework to describe and understand the origin, structure and evolution of the universe.

The Big Bang theory is the most widely accepted theory of the origin of the universe, which describes the process of the universe from an extremely high temperature and high density state to today's vast universe. However, the scientific community has not reached a unanimous conclusion about the specific state before the Big Bang. The following are several main conjectures and theories:

Nihility state

A common view is that the state of the universe before the Big Bang was nothingness, that is, there was no matter in the universe. According to this view, the Big Bang marked the beginning of time and space, and all matter and energy in the universe were generated from this Big Bang.

Singularity state

Another view is that the universe was in a singular state before the Big Bang, which is a point with infinite energy density and temperature. In this state, the existing laws of physics are invalid and cannot describe its real situation. Singularity is a limit of the Big Bang theory, but scientists can't explain why and how the transition from singularity to Big Bang occurred.

Cyclic model

Some scientists have put forward a cycle model, arguing that the universe has experienced many periodic cycles of big explosions and big collapses. In this model, the Big Bang is not the beginning of the universe, but a stage in a larger cycle. Before the Big Bang, the universe may have experienced countless similar expansions and contractions.

Quantum fluctuation

There is also a theory that the Big Bang may be caused by quantum fluctuations. In this view, the universe was born from a highly uncertain quantum state, and the Big Bang was an extreme situation caused by quantum fluctuations. This theory attempts to combine quantum mechanics with general relativity to explain the occurrence of the Big Bang.

The state of the universe before the Big Bang described by the Big Bang theory is still an unsolved mystery. The scientific community has put forward many conjectures and theories, including nihility state, singularity state, cycle model and quantum fluctuation, but there is no conclusive evidence to support any of them. With the progress of science and technology, there may be more discoveries in the future to reveal the mystery of the origin of the universe. .

Cosmic expansion theory is an important field in modern cosmology. In recent years, scientists have made some new research achievements in this field. The following are some important findings based on the latest search results.

Uneven expansion of the universe

Recent studies have found that the expansion of the universe is not uniform, but is expanding in a more diversified or "more uneven" way. The traditional cosmological model assumes that the expansion of the universe is uniform, but new research shows that this assumption may not be completely correct. The researchers found that the expansion speed of the universe is different in different regions by analyzing the enhanced light curve of type Ia supernovae. In the galaxy region with strong gravity, time passes more slowly, while in the cosmic hole, that is, the vast empty region, time passes faster. This difference leads to the so-called "wrinkle" space-time structure, and when light passes through these areas, it will be stretched, simulating the effect of accelerating expansion. Therefore, the universe may not really accelerate its expansion at the physical level, but the observation effect caused by the way people calibrate the time and distance of the heterogeneous universe.

(5) the existence of dark energy.

Dark energy is considered as a mysterious force to accelerate the

expansion of the universe, but the latest research has questioned this. The traditional cosmological model assumes that dark energy is an unknown and dominant energy form, which exerts negative pressure on the universe, counteracts gravity, and thus promotes the accelerated expansion of the universe. However, the new research found that by analyzing the light curve of type Ia supernova, the expansion of the universe may be due to the observation effect caused by the time and distance calibration method of the heterogeneous universe, rather than the real accelerated expansion. This shows that dark energy may not exist, or its action mode is different from the traditional hypothesis.

The development of the theory of cosmic expansion

The development of the theory of cosmic expansion has gone through a long historical process. From the initial steady-state cosmology to Einstein's introduction of cosmological constants to keep the universe still, and then

⑥ The reason and importance of star rotation.

The rotation of celestial bodies in the universe is a universal phenomenon, which not only exists in macroscopic celestial bodies such as stars and galaxies, but also runs through microscopic particles. The rotation of celestial bodies is closely related to its formation process. According to the law of universal gravitation, there is gravitational interaction between celestial bodies in the

universe, which will lead to mutual attraction between celestial bodies, thus avoiding collision. Therefore, the rotation of celestial bodies is not only a way to avoid collision, but also an important part of the evolution of the universe.

Formation mechanism of celestial rotation

The rotation of celestial bodies is closely related to its formation process. Nebulae produced in the early days of BIGBANG will collapse to form stars, planets, satellites and other small celestial bodies under external interference, such as nearby supernova explosions. The constituent particles of the nebula will collide with each other, so that the net angular momentum of the nebula is not zero, which leads to the overall movement of the nebula in a certain direction, and with the gravitational collapse, the nebula will rotate faster and faster in that direction. Eventually, the star forms from the center of the nebula and keeps rotating due to the conservation of angular momentum.

Influence of rotation on celestial stability

Rotation is not only a way for celestial bodies to avoid collision, but also a key factor for celestial bodies to maintain stability. No rotating celestial bodies have collided and disappeared under the action of gravity, leaving behind all rotating celestial bodies. This rotation enables celestial bodies to maintain a certain stability under the action of gravity, thus forming the cosmic structure we observe

today.

Correlation between cosmic structure and particle structure

Rotational characteristics of cosmic structure

On the macro scale, the rotation pattern of galaxies can help scientists understand their mass distribution and evolution process. For example, the planets in the solar system revolve around the sun, which not only determines the trajectories of the planets, but also affects their climate and seasonal changes. On a larger scale, the rotation pattern of galaxies reveals the structure and development of the universe II.

The relationship between the rotation of microscopic particles and the rotation of macroscopic celestial bodies

In the microscopic world, the spin of particles also follows a similar principle. Although spin is different from rotation in classical physics, the basic principle behind them-the conservation of angular momentum-is the same. This further confirms the ubiquitous nature of rotation in the universe, whether at the macroscopic celestial body or the microscopic particle level.

Influence of cosmic rotation on structural evolution

Rotation has a profound influence on the structure and development of the universe. For example, the rotation pattern of galaxies can help scientists understand their mass distribution and evolution. In addition, the early state and temperature of the universe are also crucial to the universality of the rotation phenomenon. When matter cools down, it can more easily form stable structures, such as stars, planets and even entire galaxies. During the formation of these structures, the original angular momentum is preserved, so the newly generated celestial bodies will naturally keep rotating.

Discussion on the possibility of large-scale rotation of the universe

Theoretical basis of large-scale rotation of the universe

General relativity provides a theoretical basis for us to understand the large-scale structure of the universe. Under this theoretical framework, the large-scale structures of the universe, such as galaxies, clusters of galaxies and larger structures, such as superclusters, are all formed during the expansion of the universe. With the expansion of the universe, these structures have undergone complex dynamic evolution under the action of general relativity.

Observational evidence of large-scale rotation of the universe

Although the theory that the universe rotates on a large scale has not been proved by conclusive observation, some studies suggest that some forms of deflection do exist in some areas of the cosmic microwave background radiation (CMB), which may be related to the large-scale rotation of the universe. However, these observations are not enough to determine whether the universe is really rotating, because there are other factors, such as various fluctuations and inhomogeneities of the universe, which may also have similar effects.

Future research direction of cosmic rotation

Overview of the Law of Superrotation of Planetary Celestial Bodies

The law of super-rotation of celestial bodies mainly studies the generation mechanism and evolution process of magnetic field inside planets. By numerical simulation of the magnetic field of the cold giant planet, scientists can deeply understand the evolution of the topological structure and intensity of the planetary magnetic field with time. These studies are of great significance for understanding the evolution, livability and atmospheric dynamics of planets.

⑦ Formation mechanism of planetary magnetic field

The generation of planetary magnetic field usually involves the metal elements (such as iron) inside the planet to generate electrons through nuclear fusion reaction, and these electrons flow in the magnetic field inside the planet to form a magnetic field. In addition, the movement of the liquid metal core inside the planet will also produce a magnetic field.

Evolution process of planetary magnetic field

The evolution of planetary magnetic field is influenced by many factors, including the thermodynamic state inside the planet, the distribution of metal elements and the rotation speed of the planet. Through the numerical simulation of the magnetic fields of different planets, scientists found that the planetary magnetic fields showed different topological structures and intensities at different stages of evolution.

Correlation between cosmic structure and particle structure

There is a close relationship between the structure of the universe and the structure of particles, which is mainly reflected in the interaction between the basic components of the universe-basic particles and basic forces.

The basic building block of the universe.

The basic building blocks of the universe include elementary particles and elementary forces. Basic particles include quarks and leptons, while basic forces include electromagnetic force and nuclear force. These elementary particles and fundamental forces together constitute the basic framework of the universe.

Interaction between elementary particles and elementary forces

The interaction between elementary particles and fundamental forces is the power source of the evolution of the universe. For example, electromagnetic force enables atoms to form molecules, thus forming various complex material structures; Nuclear force enables the nucleus to exist stably, thus maintaining the structure of the atom.

The relationship between the law of super-rotation of celestial bodies and the structure of universe and particles.

There is a close relationship between the law of super-rotation of stars and celestial bodies and the structure of universe and particles. This connection is mainly reflected in the following aspects:

The interaction between the generation mechanism of planetary magnetic field and the basic forces of the universe

The generation mechanism of planetary magnetic field involves that metal elements produce electrons through nuclear fusion reaction, and these electrons flow in the magnetic field inside the planet, thus forming a magnetic field. This process is similar to the interaction between elementary particles, such as quarks forming protons and neutrons through strong interaction.

Evolution process of planetary magnetic field and evolution of cosmic structure

The evolution of planetary magnetic field is influenced by many factors, including the thermodynamic state inside the planet, the distribution of metal elements and the rotation speed of the planet. The changes of these factors are similar to the evolution of the structure of the universe on different time scales, such as the formation and evolution of galaxies and galaxy clusters.

Enlightenment of the law of super-rotation of celestial bodies on the study of cosmic structure and particle structure

By studying the law of super-rotation of celestial bodies, scientists can deeply understand the generation mechanism and evolution

process of planetary magnetic field, thus providing a new perspective and method for studying the structure of the universe and the structure of particles. For example, by studying the evolution of the topological structure and intensity of the planetary magnetic field with time, scientists can explore the distribution and evolution of matter and energy in the universe.

In a word, there is a close relationship between the law of super-rotation of stars and celestial bodies and the structure of the universe and particles. By studying the law of super-rotation of celestial bodies, scientists can provide new perspectives and methods for studying the structure of the universe and the structure of particles, thus promoting the development of cosmology.

Although there is no conclusive evidence to support the rotation of the universe on a large scale, future research may provide us with more clues about this issue. For example, more accurate observation equipment and further research may reveal more evidence about the rotation of the universe. In addition, the study of the early state of the universe may also provide a new perspective for us to understand whether there is rotation in the universe.

The law of super-rotation of celestial bodies is closely related to the structure of the universe and the structure of particles. From macroscopic celestial bodies to microscopic particles, rotation is not only a universal phenomenon, but also has a far-reaching impact on the structure and development of the universe. Future research may provide us with more clues about this issue and help us better

understand the nature and evolution of the universe.

Study on the shape of dark matter halo in galaxy

As a typical disk galaxy, the Milky Way shows warping characteristics. Astronomers can reveal the structure and evolution of the Milky Way galaxy by studying the warping precession of the silver disk.

2,600 young classical Cepheid variables discovered by Gaia satellite are used as the tracer objects of the warping of the Milky Way, and the distance and age of these Cepheid variables are accurately measured by combining with the survey data of Guo Shoujing telescope. The method of "time animation" was pioneered to accurately depict the three-dimensional structure of silver plates sliced at different ages 250 million years ago.

Through the animation "projection" method, the evolution process of silver plate warping is clearly revealed, and it is found that the warping precesses at a rate of 0.12 degrees per million years along the direction of anti-sun rotation. This discovery is of great significance for understanding the structure and dynamics of the Milky Way galaxy.

Study on type Ia supernova

Type Ia supernovae can be used as a "standard candle" to measure distant distances and calculate the expansion rate of the universe (Hubble constant) because of its explosion-related parameters. However, there are differences in the values of Hubble constant measured by different methods, which leads to doubts about the standard model of cosmology.

The research team used the data of JWST's advanced deep galaxy survey to discover the oldest type Ia supernova and 80 other supernovae. Further research on these supernovae is planned to determine their metal content and exact distance.

This discovery essentially opens a new window about the transient universe, which helps to eliminate the differences in the measurement of Hubble constant and further verify the standard model 2 of cosmology.

Study on Dipole supersolid Vortex

Supersolid's theoretical concept puts forward that this state of matter has the characteristics of both solid and superfluid. Dipole interaction plays an important role in supersolid's research.

In the research published in Nature by EvaCasotti et al., the dipole

Bose-Einstein condensation (BEC) was realized by using thulium atoms with strong magnetic dipole moment, and the BEC was transformed into supersolid phase. Experiment 3 was carried out by trapping ultracold thulium atoms in optical lattice.

The vortex observed in dipole supersolid shows rich and complex dynamic characteristics, bridging the gap between the study of classical vortex in solid state system and that of quantum vortex in superfluid, which has important theoretical significance.

Study on the creation of black holes on the earth by quantum tornadoes

The rotating black hole (kerr black holes) has angular momentum, which will drag the surrounding space-time structure in the direction of its rotation. This phenomenon is called "frame drag".

By confining tens of thousands of quanta in a compact object similar to a small tornado, a record-breaking eddy current in the field of quantum fluid is realized. More complicated experiments have raised this research to a new level.

This study may eventually lead to the prediction of the behavior of quantum field in the curved space-time around the astrophysical black hole, which provides a new perspective for understanding the

properties of black holes.

● Attending Progress in Superconducting Quantum Computing

Superconducting qubits have the advantage of large-scale expansion and have developed rapidly in recent years. Realizing large-scale multi-qubit entanglement has always been the goal pursued by scientists all over the world.

This work greatly breaks the record of the number of truly entangled bits in each quantum system from 24 to 51, which fully demonstrates the excellent scalability of superconducting quantum computing system, and is of great significance to the study of multi-body quantum entanglement, the realization of large-scale quantum algorithms and quantum computing based on measurement.

Study on Spin of Supermassive Black Hole

The energy transfer mechanism between supermassive black holes and their accretion disks and relativistic jets has been puzzling physicists and astronomers. A popular theory holds that energy can be extracted from rotating black holes, allowing some substances around supermassive black holes to be ejected with great energy.

By analyzing the VLBI data of M87 obtained in the past 23 years, the research team detected a periodic precession jet at its bottom, thus gaining a deeper understanding of the state of the central black hole.

The detection of this precession provides clear evidence that the supermassive black hole in M87 is indeed rotating, thus enhancing our understanding of the nature of supermassive black holes.

These latest research advances not only promote our understanding of the law of super-rotation of celestial bodies in theory, but also show great potential in practical application. From the study of the shape of dark matter halo in the Milky Way to the progress of superconducting quantum calculation, every achievement has opened up a new way for future scientific research.

Cosmic expansion and dark energy

Recently, a group of physicists and astronomers from Canterbury University in New Zealand challenged the traditional view of the expansion of the universe. By analyzing the enhanced light curve of type Ia supernovae, they found that the expansion mode of the universe is more diverse or "uneven" than previously thought, and the dark energy may not actually exist. This discovery supports the "time landscape" model, which tries to explain the accelerated expansion of the universe without assuming the existence of dark energy. It is pointed out that in the galaxy region with strong gravity,

time passes more slowly, while in the cosmic hole (vast empty region), time passes more quickly. This difference creates the so-called "wrinkled" space-time structure.

A new understanding of the age of the universe

Initial state: the origin of the universe

Big bang universe model

In the study of cosmology, the most widely accepted model of the origin of the universe is the Big Bang model. The model holds that the universe originated from a state of extremely high temperature and density about 13.8 billion years ago, and then experienced rapid expansion and cooling, forming the cosmic structure we observed today.

Steady-state universe model

Another early cosmological model is the steady cosmological model, which was put forward by Band-Aid, Gold and Fred Huo Yier in 1948. The model holds that the universe is infinite in time and space, and the expansion of the universe is accompanied by the continuous production of new substances to keep the density of

cosmic substances unchanged. This model tries to solve the problem about the age of the universe in the Big Bang model, but it is not widely recognized because it is inconsistent with the observed results.

Final state: the fate of the universe

The final state of the big bang model

In the Big Bang model, the final state of the universe depends on the total density of the universe. If the density of the universe is high enough, gravity will eventually lead to the contraction of the universe and may experience a "big collapse". If the density is low, the universe will continue to expand until all the stars run out of fuel and enter a cold and dark "heat silence" state.

The final state of the steady-state universe model

The steady-state universe model assumes that the universe has no real final state, because it thinks that the universe is infinite in time and space, and matter is constantly produced to maintain a constant density. Therefore, the model has no clear final concept 1.

Constant state of changing motion

The dynamic evolution of the universe

Whether it is the Big Bang model or the steady-state model, the universe is constantly moving and changing. In the Big Bang model, the universe started from a high-density and high-temperature state and gradually expanded and cooled, forming galaxies, stars and planets. In the steady-state model, although the universe as a whole remains unchanged, the material distribution in local areas will change, new galaxies will be formed continuously, and old galaxies will gradually age 1.

Dynamic evolution of ii microscopic particles

At the microscopic level, particles are constantly moving and changing. For example, when electrons revolve around the nucleus, atoms will vibrate, decay and radiate energy. Photons, neutrinos and other elementary particles move at high speed in space, and energy is constantly exchanged and transferred between substances. The change process of these microscopic particles is also a manifestation of the passage of time 2.

The initial state, final state and constant state of changing motion of the universe and particle structure constitute our understanding of the evolution of the universe. The big bang model provides the most widely accepted

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